

Postprocessing and Analysis

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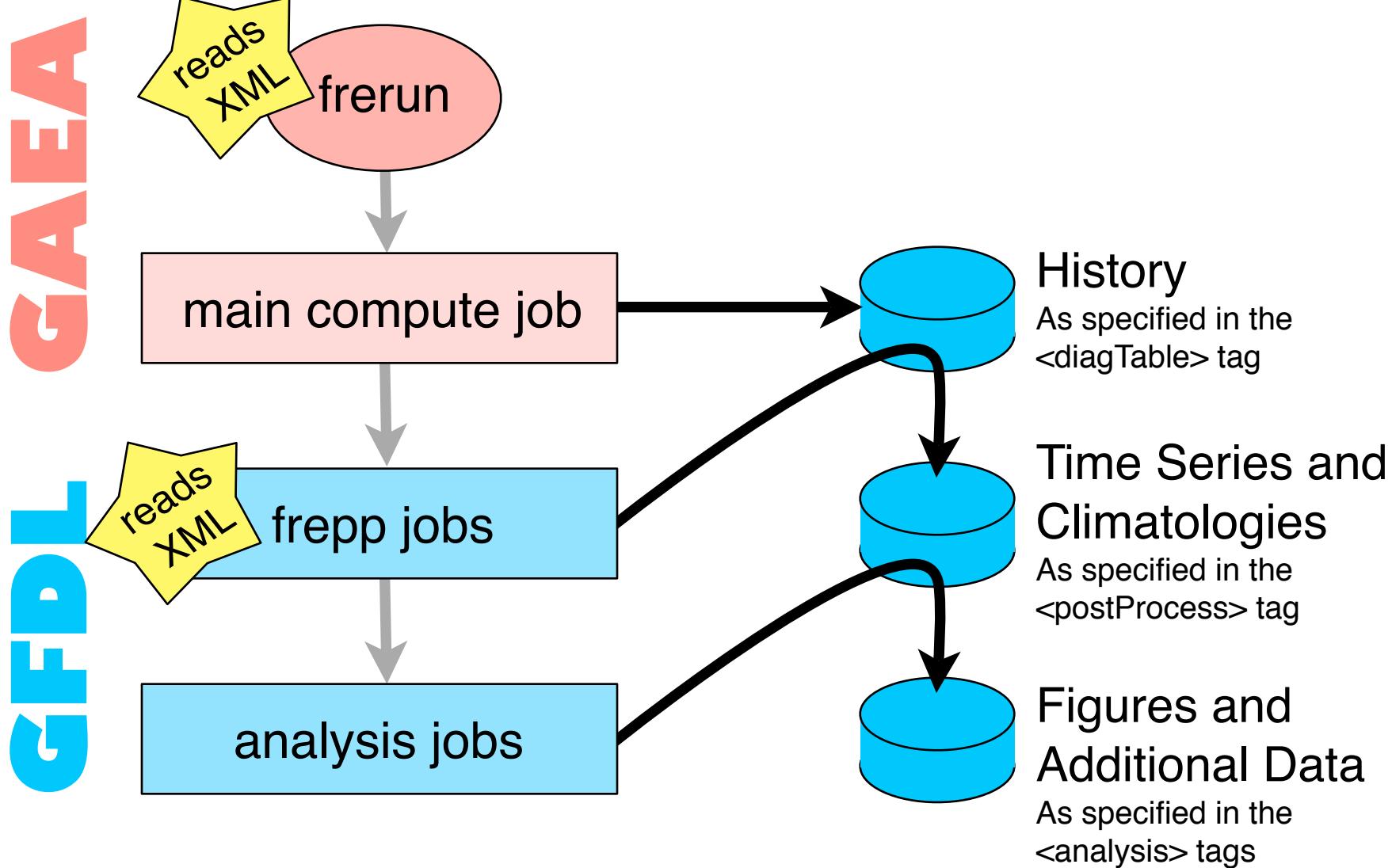
Outline: Postprocessing/Analysis

- **Following Diagnostic Variables Through The Workflow**
- Available Post-processing Options
- Adding Automated Analysis
- Exercises

Log on to analysis to follow along:

`ssh Student.xx@analysis`

Simplified Postprocessing Flow



Diagnostics Table

- Set in the XML

```
<diagTable>
```

```
$name
```

```
$baseDate
```

```
"atmos_month", 1, "months", 1, "days", "time",  
"moist",      "precip",   "precip",   "atmos_month", "all", .true., "none", 2  
"moist",      "temp",     "temp",     "atmos_month", "all", .true., "none", 2  
"radiation", "lwdn_sfc", "lwdn_sfc", "atmos_month", "all", .true., "none", 2  
"radiation", "lwup_sfc", "lwup_sfc", "atmos_month", "all", .true., "none", 2
```

```
</diagTable>
```

Postprocessing Specification: TS

```
<postProcess>
    <component type="atmos" source="atmos_month" start="2001"
        cubicToLatLon="90,144" zInterp="era40">
        <timeSeries freq="monthly" chunkLength="10yr">
            <variables> precip, temp </variables>
        </timeSeries>
    </component>
</postProcess>
```

Or, process all variables in the diagnostic file:

```
<postProcess>
    <component type="atmos" source="atmos_month" start="2001"
        cubicToLatLon="90,144" zInterp="era40">
        <timeSeries freq="monthly" chunkLength="10yr"/>
    </component>
</postProcess>
```

Postprocessing Specification: AV

```
<postProcess>
    <component type="atmos" source="atmos_month" start="2001"
        cubicToLatLon="90,144" zInterp="era40">
        <timeSeries freq="monthly" chunkLength="10yr">
            <variables> precip, temp </variables>
        </timeSeries>
        <timeAverage source="monthly" interval="10yr"/>
    </component>
</postProcess>
```

History Output

```
> ls $archiveDir/history
20000101.nc.tar  20030101.nc.tar  20060101.nc.tar  20090101.nc.tar
20010101.nc.tar  20040101.nc.tar  20070101.nc.tar  20100101.nc.tar
20020101.nc.tar  20050101.nc.tar  20080101.nc.tar

> cd $TMP; gcp $archiveDir/history/20010101.nc.tar .
> tar -xvf 20010101.nc.tar
20010101.atmos_month.tile1.nc
20010101.atmos_month.tile2.nc
20010101.atmos_month.tile3.nc
20010101.atmos_month.tile4.nc
20010101.atmos_month.tile5.nc
20010101.atmos_month.tile6.nc

> ncdump -h 20010101.atmos_month.tile1.nc
dimensions:
    grid_xt = 48 ;
    grid_yt = 48 ;
    time = UNLIMITED ; // (12 currently)
    nv = 2 ;
variables:
    float precip(time, grid_yt, grid_xt) ;
        precip:long_name = "Total precipitation rate" ;
        precip:units = "kg/m^2/s" ;
```

Postprocessing Output: TS

```
> ls $archiveDir/pp/atmos/ts/monthly/10yr

atmos.200101-201012.precip.nc
atmos.200101-201012.temp.nc
atmos.200101-201012.mon.nc.cpio

> ncdump -h atmos.200101-201012.precip.nc

dimensions:
    time = UNLIMITED ; // (120 currently)
    bnds = 2 ;
    lat = 90 ;
    lon = 144 ;
variables:
    float precip(time, lat, lon) ;
        precip:long_name = "Total precipitation rate" ;
        precip:units = "kg/m2/s" ;
        precip:missing_value = 1.e+20f ;
        precip:_FillValue = 1.e+20f ;
        precip:cell_methods = "time: mean" ;
        precip:time_avg_info = "average_T1,average_T2,average_DT" ;
        precip:interp_method = "conserve_order1" ;
    ...
```

Postprocessing Output: AV

```
> ls $archiveDir/pp/atmos/av/monthly_10yr
```

```
atmos.2001-2010.01.nc  atmos.2001-2010.05.nc  atmos.2001-2010.09.nc  
atmos.2001-2010.02.nc  atmos.2001-2010.06.nc  atmos.2001-2010.10.nc  
atmos.2001-2010.03.nc  atmos.2001-2010.07.nc  atmos.2001-2010.11.nc  
atmos.2001-2010.04.nc  atmos.2001-2010.08.nc  atmos.2001-2010.12.nc
```

```
> ncdump -h atmos.2001-2010.01.nc
```

dimensions:

```
time = UNLIMITED ; // (1 currently)  
bnds = 2 ;  
lat = 90 ;  
lon = 144 ;
```

variables:

```
float precip(time, lat, lon) ;  
    precip:long_name = "Total precipitation rate" ;  
    precip:units = "kg/m2/s" ;  
    precip:missing_value = 1.e+20f ;  
    precip:_FillValue = 1.e+20f ;  
    precip:cell_methods = "time: mean" ;  
    precip:time_avg_info = "average_T1,average_T2,average_DT" ;  
    precip:interp_method = "conserve_order1" ;
```

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Postprocessing Outputs

- **Time series**
 - One variable per file
 - Chunks less than 20 years have netcdf files plus one cpio file per chunk
 - Use frescrub to delete netcdf files
 - Allows you to look at individual files but archive your data more efficiently
 - Chunks of 20 or more years have netcdf files only

```
<timeSeries freq="daily" chunkLength="10yr"  
source="atmos_daily"/>
```

Time Series Frequencies

- Hourly time series from hourly history data
 - '1hr','2hr','3hr','4hr','6hr','8hr','12hr','120hr'
- Daily time series from daily history data
- Monthly time series from monthly or daily history data
- Annual time series from monthly time series or annual history data
- Seasonal time series (with standard seasons DJF, MAM, JJA, SON) from monthly time series

Postprocessing Outputs

- **Time Averages**
 - Climatology files with all variables in one file
 - ie, an average of ten Januaries
 - One averaged time level per file
 - No cpios are created

```
<timeAverage source="monthly" interval="10yr"/>
```

Time Average Source Frequencies

- Monthly time averages from monthly history data
- Annual averages from monthly or annual history data
- Seasonal averages (with standard seasons DJF, MAM, JJA, SON) from monthly history data

Frepp Features

- Will create a static file for each component
- Will calculate longer time series/averages from shorter ones
 - If you request five and fifty year time series chunks, frepp will create the fifty year chunks by concatenating five year chunks.
- Is aware of its state
 - If you request five and fifty year time series from 1951-2000 but you forgot to run 1995 or that job failed, frepp will run it automatically.

Frepp Features

- Can be called by the workflow as the model runs, or manually/offline
- If you want to create a ten year time series from 1981-1990, you should call frepp on year 1990, the last year of data needed for the time series
- Sample **frepp** command

```
frepp -t 1990 -c atmos -d $historyDir -x AM3.xml  
-P gfdl.ncrc2-intel -T prod-openmp c48L48_am3p10
```

Regridding Options

- XY
 - latlon remaining latlon
 - cubed sphere remaining cubed sphere
 - cubed sphere regridded to latlon
 - use “cubicToLatLon” attribute with the latlon grid resolution in x,y as the value
- Z
 - native model levels
 - pressure level interpolation
 - use “zInterp” attribute with one of the predefined sets: ncep, am3, hs20, era40, narcaap, ar5daily, ncep_subset

Auxiliary Tools

- **freppcheck**
 - check for missing postprocessing files
- **refrepp**
 - launch frepp jobs to create missing files
- **frescrub**
 - delete intermediate postprocessing output

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Analysis

```
<postProcess>
    <component type="atmos" source="atmos_month" start="2001"
                cubicToLatLon="90,144" zInterp="era40" >
        <timeSeries freq="monthly" chunkLength="10yr">
            <analysis script="$FRE_ANALYSIS_HOME/cjg/stub/
cjg_atmos_ts_mon.csh"/>
        </timeSeries>
    </component>
</postProcess>
```

The template script contains variables to be filled by frepp, ie:

```
set in_data_dir      #pp directory containing files to be analyzed
set in_data_file    #list of all filenames to be analyzed
set descriptor       #experiment name
set out_dir          #directory to write output files
set yr1              #first year to analyze
set yr2              #last year to analyze
...
```

XML XIncludes

```
<postProcess>
  <component type="atmos" source="atmos_month" start="2001"
    cubicToLatLon="90,144" zInterp="era40" >
    <timeSeries freq="monthly" chunkLength="10yr">
      <xi:include href="$FRE_ANALYSIS_HOME/cjg/xml/
analysis_scripts.xml" xpointer="xpointer(* /atmosMonthTS/*)">
        <xi:fallback/>
      </xi:include>
    </timeSeries>
  </component>
</postProcess>
```

XInclude is a generic mechanism for merging XML documents, by writing inclusion tags in the "main" document to automatically include other documents or parts thereof. (*Wikipedia*)

XInclude file analysis_scripts.xml

```
<analysisScripts>
  <atmos8xDailyTS>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/cjs_precip_intensity.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/cjs_precip_intensity2.csh"/>
  </atmos8xDailyTS>
  <atmosDailyTS>
    <analysis script="$FRE_ANALYSIS_HOME/bw/stub/bw_cru_temp.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/wheeler_kiladis.csh"/>
  </atmosDailyTS>
  <atmosMonthTS>
    <analysis script="$FRE_ANALYSIS_HOME/cjg/stub/cjg_atmos_ts_mon.csh"/>
  </atmosMonthTS>
  <atmosMonthAve>
    <analysis script="$FRE_ANALYSIS_HOME/bw/stub/bw_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/bw/stub/bw_cru_precip.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/bw/stub/pjk_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/bw/stub/tk_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjg/stub/cjg_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/radiation_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/sak_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/sak_lwp_atmos_av_mon.csh"/>
    <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/sak_precip_atmos_av_mon.csh">
      <analysis script="$FRE_ANALYSIS_HOME/cjs/stub/yim_aer_cld.csh"/>
    </atmosMonthAve>
```

Sample Analysis Script

```
#!/bin/csh -f
#PBS -N cjh_atmos_ts_mon
#PBS -l size=1
#PBS -l walltime=04:00:00

# variables set by frepp
set in_data_dir
set descriptor
set out_dir
set yr1
set yr2
set databegyr
set dataendyr
set datachunk

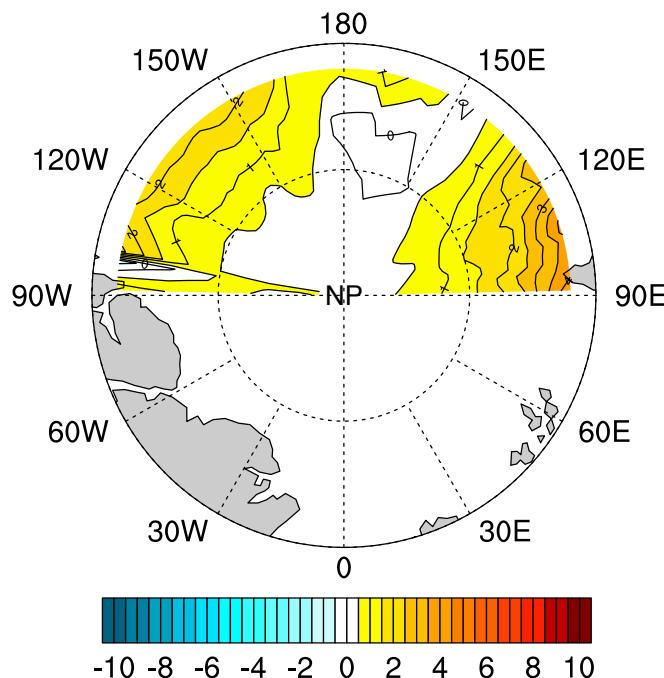
source $MODULESHOME/init/csh
module load ncarg

# Run script
set script_bash = $FRE_ANALYSIS_HOME/cjh/code/cjh_mon_ts/cjh_mon_ts.bash
$script_bash -i $in_data_dir -o $out_dir -d $descriptor \
-y $yr1,$yr2,$databegyr,$dataendyr,$datachunk
```

Net Arctic surface flux ($80\text{-}90^\circ \text{N}$, $90\text{-}270^\circ \text{E}$)

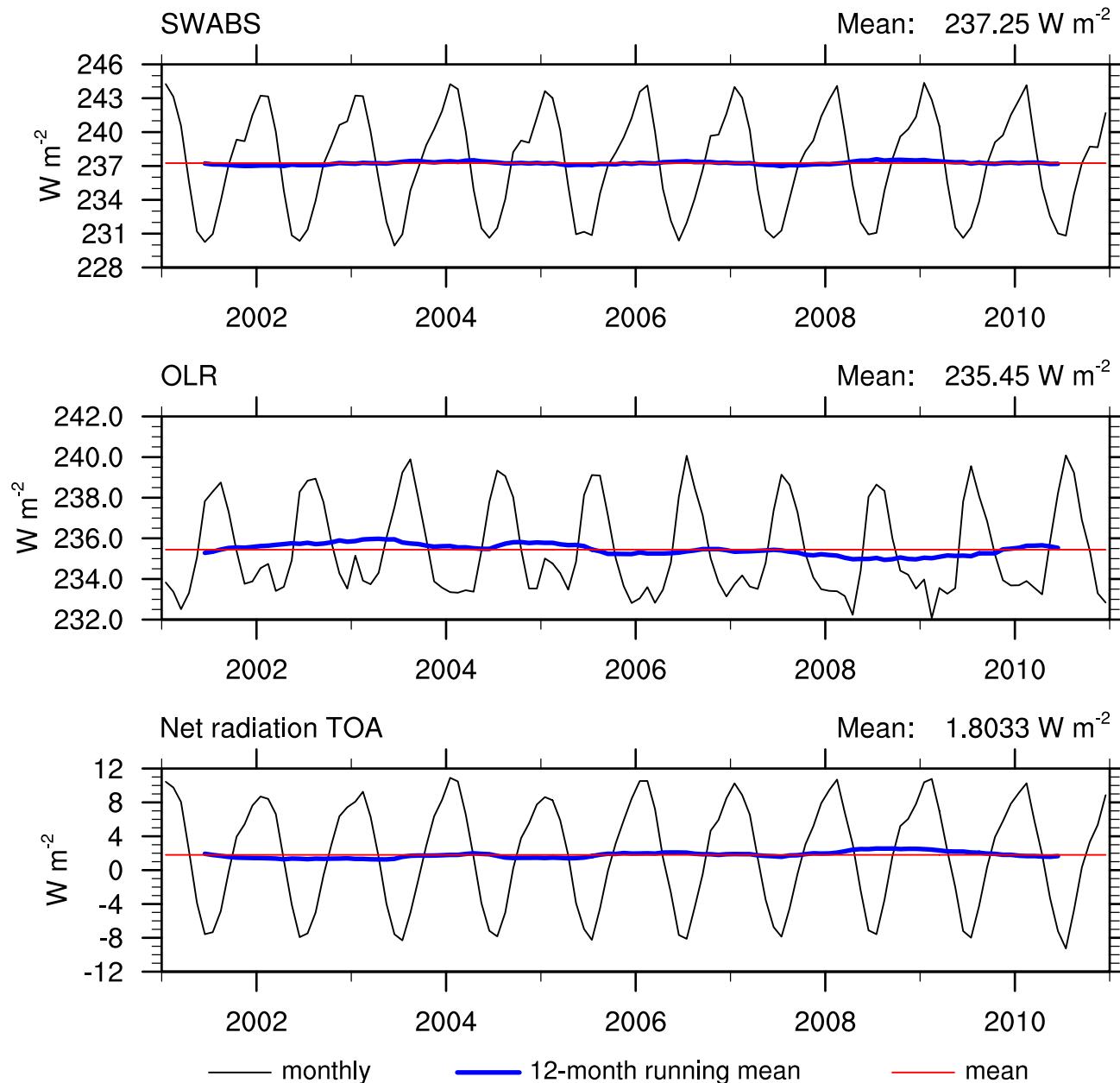
c48L48_am3p10_control

net_sfc = swdn_sfc - swup_sfc + lwdn_sfc - lwup_sfc - shflx - Lv*evap - Lf*snow



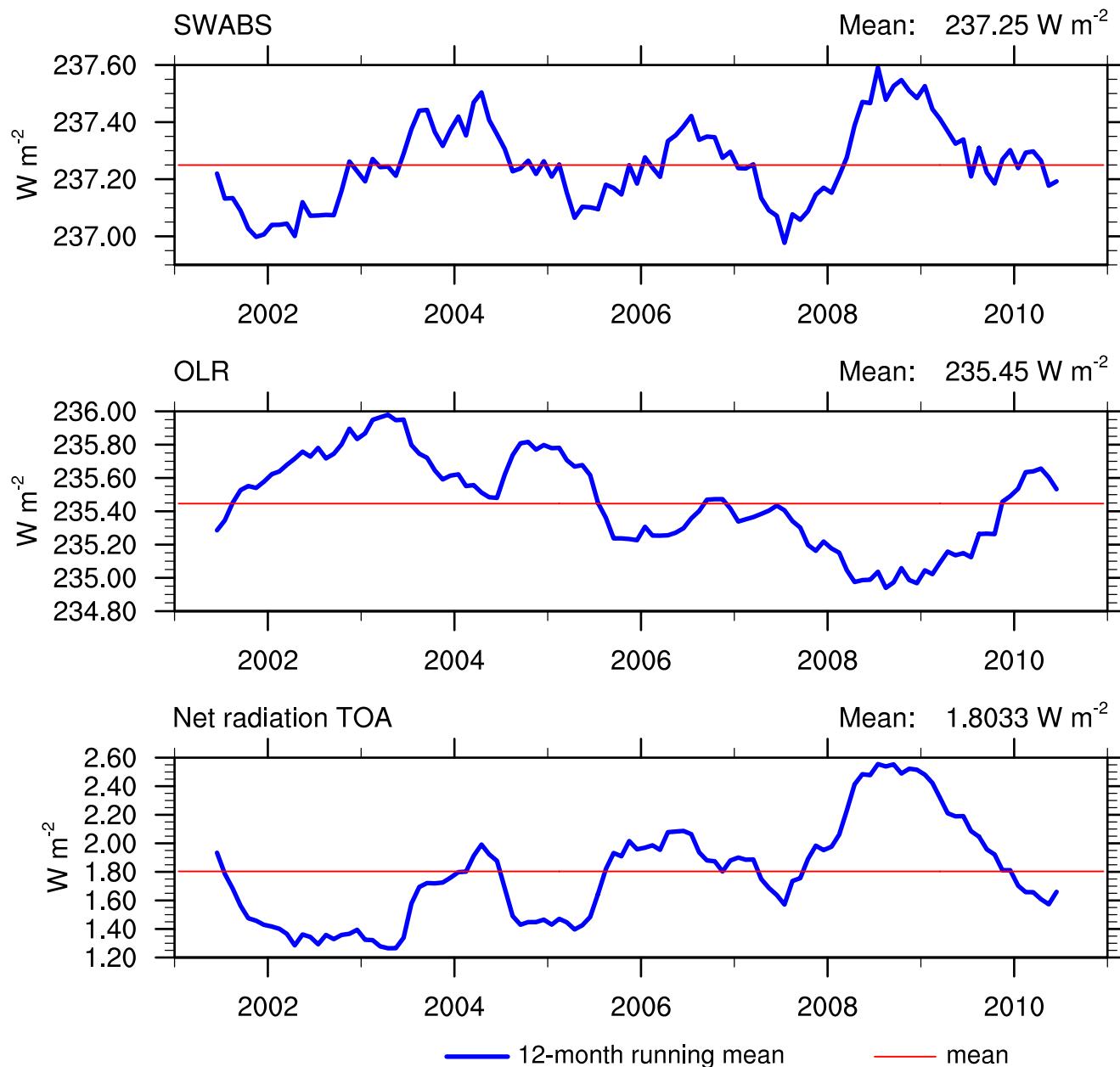
TOA global radiation fluxes

c48L48_am3p10_control



TOA global radiation fluxes

c48L48_am3p10_control



Frepp's Analysis Options

- Sample **frepp analysis** command

```
frepp -A -R -x AM3.xml -P gfdl.ncrc2-intel  
-T prod-openmp c48L48_am3p10
```

-A run analysis only
-R regenerate analysis
-Y analysis start year
-Z analysis end year

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Exercises

- Exercises are listed on the Summer School wiki page in the “Scientific Applications” section.

Questions?

- For more details on FRE, see:

<http://www.gfdl.noaa.gov/fms-fre-usage>

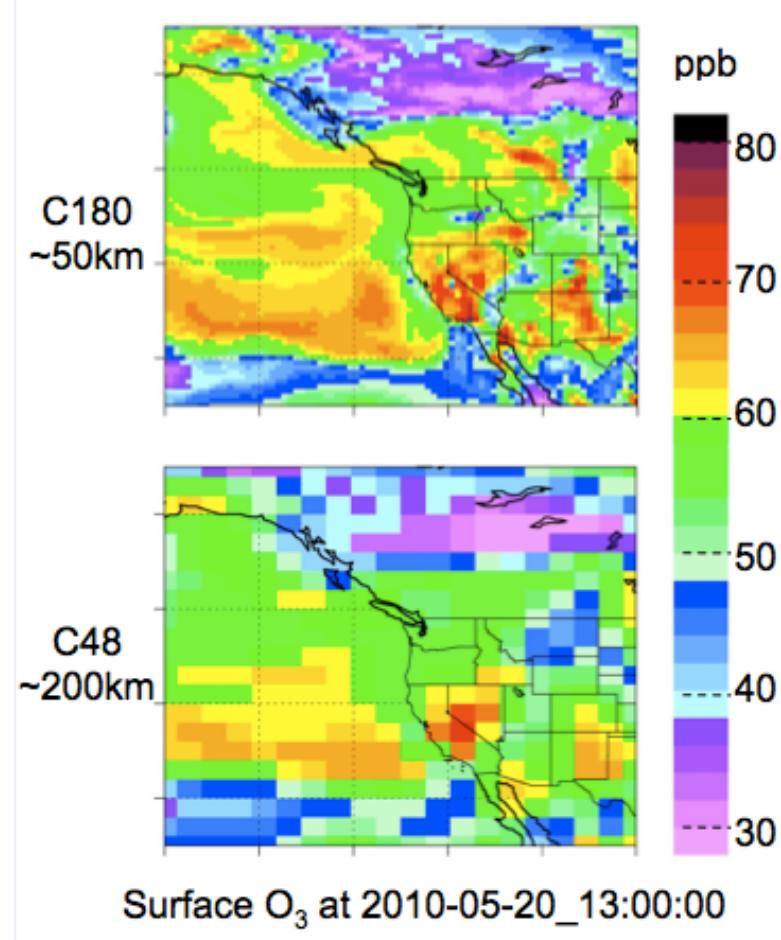


Image by
Meiyun Lin